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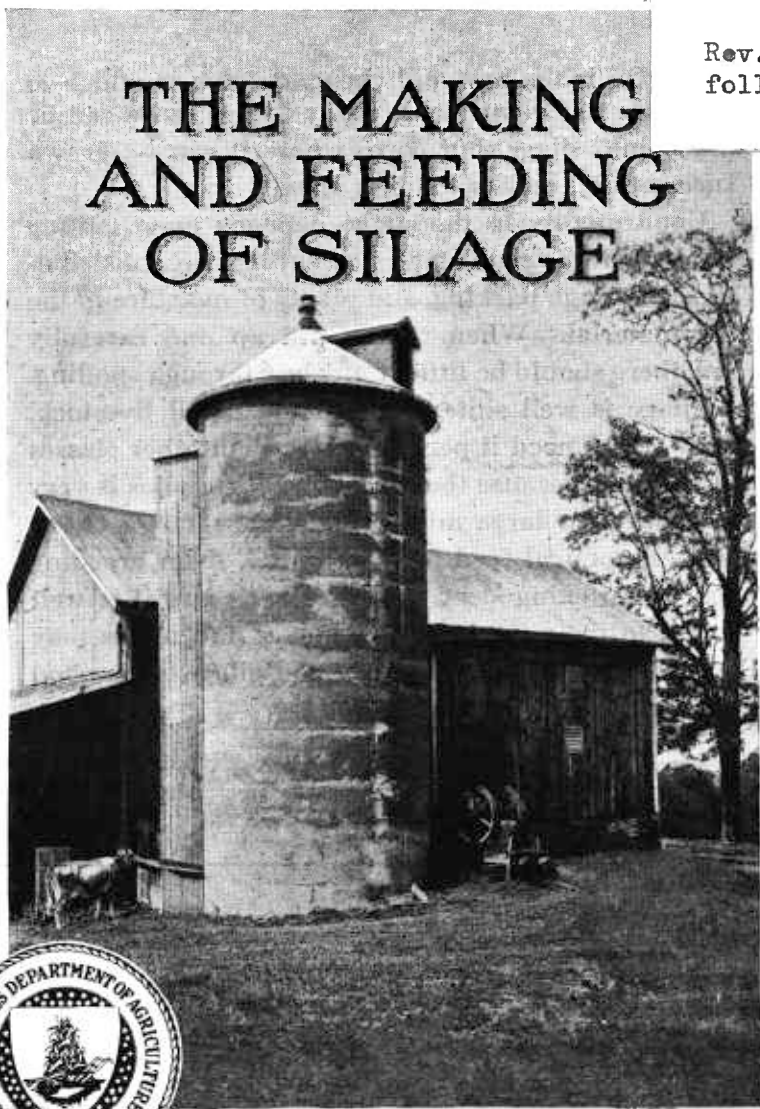
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THE MAKING AND FEEDING OF SILAGE



SILAGE is the best and cheapest form in which to store succulent feed. Many forage crops can be made into silage, but corn, where it can be grown successfully, makes the best silage.

Good quality in the silage depends upon cutting the crop at the right stage, fine cutting, even distribution, thorough packing, and plenty of moisture in the cut material. When rightly put up and carefully fed, there should be little if any loss through spoiling.

Silage is well suited for feeding to all livestock. Dairy cows need it perhaps more than other classes of animals, because the succulence it supplies is very necessary for large milk production. It is a cheap and economical feed for beef cattle, from breeding cow to fattening steer. Sheep like it and it is well suited to their needs. Even horses and mules may be fed limited quantities of good silage with good results.

THE MAKING AND FEEDING OF SILAGE

By T. E. WOODWARD and J. B. McNULTY, *Bureau of Dairying*; and GEORGE M. ROMMEL, E. W. SHEETS, and F. R. MARSHALL, *Bureau of Animal Industry*¹

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MANUFACTURE AND FEEDING VALUE OF SILAGE

By T. E. WOODWARD and J. B. McNULTY, *Bureau of Dairying*

SILAGE is any food material that has been cut and packed in an air-tight container or pit, with moisture enough to allow a partial fermentation, which preserves it in a slightly sour condition.

Dairymen and feeders of cattle have long appreciated the value for milk and meat production of the succulent pasture grasses which are so abundant in the spring and summer. To obtain succulence in the winter or when pasture is not available, forage crops are made into silage.

Silage has certain laxative properties which keep the digestive organs of animals in good condition. Livestock receiving some form of succulent feed have keener appetites, softer and more pliable skins, and a more thrifty, more healthy appearance than those fed exclusively on dry rations.

CROPS SUITABLE FOR SILAGE

Almost any green crop can be made into silage successfully. Considerable care must be taken, however, to expel the air from such hollow-stemmed plants as the small cereal grains by cutting fine and packing firmly. Other crops, legumes for example, are deficient in the fermentable constituents needed for palatable silage. On the other hand, a few crops, such as the sorghos, have so much sugar that unless cut at a more mature stage they have a tendency to produce sour silage.

CORN

Corn is the common silage crop wherever it can be grown successfully. (See fig. 1.) Silage made from corn has a good flavor, is very palatable, and will keep in good condition for years. It contains nearly as high a percentage of digestible nutrients as the corn from which it was made. When it is properly siloed, the losses of

¹ Mr. McNulty resigned from the department Aug. 26, 1919, and Mr. Rommel Oct. 31, 1921.

digestible nutrients from fermentation are smaller than in most other crops.

In most parts of the United States more food material can be obtained from an acre of corn as silage than from an acre of any other crop that can be grown. Corn is more easily harvested and put into the silo than crops like rye, clover, cowpeas, or alfalfa, and when cut for silage the maximum quantity of nutrients is preserved. Experiments have shown that corn, when siloed, lost about one-sixth of the dry matter against one-fourth when cut for fodder and cured in the field.² Moreover, there is less waste in feeding silage than in feeding fodder, since good silage properly fed is all consumed. When corn is cut for silage the land is cleared and left ready for another crop sooner than when the corn is shocked or is



FIG. 1.—Well-eared corn makes silage of the best quality

husked from the standing stalk. Corn can be put into the silo at a cost not above that of shocking, husking, grinding, and shredding.

In spite, however, of the many strong points in favor of corn as a silage crop, it is not a perfect ration, because it is low in both protein and mineral matter. Sometimes, in filling the silo, clover, cowpeas, soybeans, or alfalfa is mixed with corn in order to correct the deficiency of protein. This is not to be advised if legumes can be harvested successfully for hay. Since livestock need dry roughage, it is usually more satisfactory to feed legumes, such as clover and alfalfa, as hays rather than to mix them with the corn when filling the silo.

VARIETIES TO PLANT

As there is a steady increase in all nutrients of a corn crop up to maturity, it is best to plant a variety of corn that will mature

² A Book on Silage, F. W. Woll, 1900.

sufficiently for silage before frost. In any locality the variety commonly raised for grain is ordinarily the most satisfactory for silage, as the grain contains more nutrient than all the rest of the plant. In certain localities where there is a scarcity of succulence or roughage it is often advisable to plant a variety that yields a larger proportion of stalks and leaves and less grain than most northern corn.

In Table 1 (from the First Annual Report of the Pennsylvania State College) it may be noted that 63 per cent of the digestible food materials present in the corn plant are found in the ears and 37 per cent in the stover.

TABLE 1.—Yield per acre of digestible matter in corn

Constituents	Yield per acre		
	Ears	Stover	Total crop
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Protein.....	244	83	327
Carbohydrates.....	2,301	1,473	3,774
Fat.....	125	22	147
Total.....	2,670	1,578	4,248

METHODS OF PLANTING

Corn for silage is often planted more thickly than for grain, a very common practice being to plant it 6 to 10 inches apart in rows from 3 feet 4 inches to 3 feet 8 inches apart. This method of planting, however, allows cultivation in one direction only, and is not recommended for weedy land. If serious trouble with weeds is expected, the corn should be planted in hills so that it can be cultivated both ways. When there is sufficient rainfall thick planting yields as a rule more per acre, but the silage does not contain as high a percentage of digestible nutrients as in thin planting. At the farm of the Bureau of Dairying, Beltsville, Md., it was found that corn planted at the rate of four stalks to the hill yielded a somewhat greater tonnage but very little more digestible food material than at the rate of two stalks to the hill. In all cases the fertility of the land influences, to some extent at least, the rate of planting. Thick planting is usually more successful on rich soil than on poor soil.

YIELD

From 4 to 20 tons of silage can be obtained from an acre of corn. A 50-bushel crop of corn yields from 8 to 12 tons of silage per acre, depending upon the amount of leaves and stalks that accompany the ears and upon the stage of maturity at which it is siloed. The quantity of silage that may be expected per acre is often roughly estimated at 1 ton for each 5 or 5½ bushels of shelled corn. Southern varieties of corn as a rule have a larger proportion of stalks and leaves than northern-grown varieties.

TIME TO HARVEST

Ordinarily corn should be harvested for the silo about a week or 10 days before it would be cut for shocking; that is, when about 90

per cent of the kernels are dented and at least 75 per cent of the kernels are hardened so that no milk can be squeezed out. At this time the lower leaves on the stalk are turning brown and the green corn fodder contains 65 or 70 per cent of moisture, which is sufficient for silage. Silage made from corn containing moisture enough for proper preservation is more palatable than that made from corn so mature as to require the addition of water.

Table 2 (taken from the Eighth Annual Report of the New York State Agricultural Experiment Station) shows the steady increase in the yield of food nutrients per acre up to the time the corn is ripe. For this reason the corn plant should be allowed to mature as much as possible and still have moisture enough to pack the corn properly in the silo without the addition of water. Probably the moisture content should not fall below 65 per cent or exceed 75 per cent. Of course, where a large quantity of silage is made and the operation lasts for weeks the moisture content can not be kept within those limits.

TABLE 2.—*Chemical changes during growth of corn plant*

Yield per acre	Stage of growth				
	Tasseled, July 30	Silked, Aug. 9	Milk, Aug. 21	Glazed, Sept. 7	Ripe, Sept. 23
Total yield	Pounds 18,045.00	Pounds 25,745.00	Pounds 32,600.00	Pounds 32,295.00	Pounds 28,460.00
Water	16,426.00	22,666.00	27,957.00	25,093.00	21,542.00
Dry matter	1,619.00	3,078.00	4,643.00	7,202.00	7,918.00
Ash	138.91	201.30	232.15	302.48	334.23
Albuminoids	239.77	436.76	478.69	643.86	677.78
Crude fiber	514.19	872.93	1,261.97	1,755.85	1,734.04
Nitrogen-free extract	653.91	1,399.26	2,441.29	4,239.82	4,827.60
Fat	72.20	167.75	228.90	259.99	314.34

IMMATURE AND FROSTED CORN

When weather conditions such as hail, drought, or frost prevent the maturing of corn for the silo, it may be cut while still immature and produce a fair grade of silage. A good practice is to mix such corn with some which is more mature. Silage from immature corn will be more sour than usual and more laxative when fed in large quantities, a trouble that can be avoided by care in feeding.

Frosted corn dries out very quickly and many leaves are lost in handling. The corn may be so dry, also, that it will not pack well, which necessitates the addition of considerable water at the time of filling. Frosted corn should be cut as soon as possible, in order to prevent excessive drying out. If this is done the stalks may contain sufficient moisture for satisfactory silage without adding water. The frosting of the corn causes only a small loss in feeding value, the greatest loss being due to the loss of leaves in handling and the possible spoiling of part of the silage owing to its failure to pack properly.

DRY CORN FODDER

Sometimes there is a delay in filling the silo and it is necessary to cut and shock the corn; also, on farms which have a limited silo

capacity, it is often desired to refill the silos after the silage has been fed out. Dry corn fodder may be siloed successfully, but it is absolutely necessary that water enough be added to make it pack well in the silo. Water may be added by allowing a stream from a hose to flow into the blower or the top of the blower pipe while filling. In addition, it is desirable to sprinkle the surface of the cut material as it is distributed in the silo. Corn-fodder silage is not so palatable nor so good as silage made when the corn is at the proper stage. It also lacks the aroma of good corn silage. The Missouri station reports that the water to be added should be of the same weight as the corn fodder.³ Owing to the large quantity of water required, siloing corn fodder is advisable only on farms having a water system.

Corn stover likewise can be made into silage by the same methods. It lacks flavor and palatability and is low in feeding value. It is doubtful whether the making of such silage is an economical practice.

SORGHUMS

Sorgos, such as Amber cane and Orange cane, and sorghums such as kafir, feterita, milo, and Sudan grass, are all suitable for silage. On account of their greater resistance to drought, sorghums are more dependable and yield more in those regions of the South and West where the rainfall is too light or irregular for a good growth of corn. For successful silage it is important that they be harvested when the seed has become hard. If harvested earlier, a silage with a high acid content is produced. Experiments in Kansas⁴ and California⁵ indicate that there is little difference in feeding value between sorghum and corn silage. A mixture of corn and sorghum has proved to be satisfactory in some localities where the rainfall is so variable as to make the corn crop uncertain.



FIG. 2.—Shock corn, if properly handled, will make fair silage

³ Circular No. 71, Missouri Agricultural Experiment Station.

⁴ Circular 28, Kansas Agricultural Experiment Station.

⁵ Bulletin 282, California Agricultural Experiment Station.

LEGUMES

The legumes include the clovers, alfalfa, cowpeas, soybeans, velvet beans, and the vetches. All such forage crops, if properly handled, yield a fairly high grade of silage. Whenever possible it is a much better plan to cut and cure legumes for hays, for while high in protein and mineral matter they are low in sugars, which produce the desirable fermentation characteristic of corn silage. It is probable that the small quantity of sugar in legumes is responsible for the lower palatability and shorter keeping qualities of legume silage as compared with silage made from corn or the sorghums. It has been reported⁶ that when ordinary blackstrap molasses is added to alfalfa silage at the rate of 1 part to 20 by weight there is a very marked improvement in the flavor, palatability, and keeping qualities of the silage. Most legumes should be cut for silage at the same time as for hay.

There is a tendency in all feeds, when put into a silo, for the food nutrients to decrease slightly. This is due, in part at least, to the losses from fermentation. Legumes in particular suffer a decided loss in nutrients. Legume silage does not pack so well as corn silage, and for this reason it should be cut very fine and firmly tramped. A shallow silo is especially unsatisfactory. Corn or sorghum when mixed with legumes improves both the flavor and the keeping qualities of the silage.

Cowpeas and soybeans may be siloed separately, but generally they are used in combination with corn or sorghum. They are grown either in separate fields or with the corn. Cowpeas when grown with corn climb the stalks and make harvesting difficult. Soybeans being self-supporting can be harvested readily with the corn by means of a corn binder. For this reason and because they can be planted earlier in the season, soybeans make a more satisfactory crop to grow with the corn.

A strong odor is imparted to milk if legume silage is fed to cows immediately before they are milked or if milk is exposed to the odors of the feed. It is therefore advisable to feed legume silage either immediately after milking or several hours before.

SMALL GRAINS

When small grains, such as wheat, barley, buckwheat, rye, and oats, are used for silage they should be cut when the kernel is just passing from the milk into the dough stage. It is very important to cut them fine and pack them firmly in the silo. The small grains ordinarily make more palatable silage than the legumes, but are inferior to either corn or sorghum. Because of the early stage at which they must be cut and the normal loss from fermentation, there is a marked loss in digestible nutrients in silage made from small grains as compared to maturing them for grain. It is usually advisable, therefore, to harvest them for grain. Only when corn or sorghum can not be grown successfully and the need of succulent feed is great is it desirable to cut small grains for silage.

The same precautions to avoid giving milk an objectionable flavor, as mentioned for legume silage, are necessary with silage made from small grains. Rye silage especially is likely to affect the flavor of milk.

⁶ O. E. Reed in *Hoard's Dairyman*, Mar. 16, 1917.

FIELD PEAS AND OATS, OR VETCH AND WHEAT

Peas and oats or vetch and wheat planted together make a palatable silage high in protein, and are particularly adapted to sections of the United States where the climate makes the growing of corn or sorghum uncertain or impossible. The best time to cut these crops for silage is when the oats or wheat begin to pass from the milk into the dough stage, and when the pea or vetch pods have fair-sized seeds in them. Seldom, however, can both crops be siloed at the proper stage. Peas that are planted from 7 to 10 days earlier than the oats usually reach the right stage for siloing at the same time as the latter. Fine cutting and hard tramping are necessary when peas and oats or vetch and wheat are siloed together.

MILLET

The millets are not generally used as silage crops, although those who have had experience with them say that a fair grade of silage can be made if the crop is cut when nearly ripe enough for seed. It should be cut fine and packed firmly in the silo. As a rule, however, the millets are more profitable when used as soiling crops or as hays.

PEA VINES

Pea vines from canning factories are used for silage. In feeding value they are about equal to corn silage, being a little richer in protein, but containing about the same quantity of total digestible nutrients. Frequently pea vines are stacked instead of being put into the silo, in which case considerable loss occurs, especially if the stack is opened in warm weather. Stacked pea vines should not be opened until cold weather or until such time as the silage can be fed continuously. Pea-vine silage is rather laxative and should always be fed with care. Because of its strong odor it should always be fed after milking.

BEET TOPS

If properly handled, beet tops and crowns can be made into good silage. The tops should be run through the cutter and put into the silo promptly after the beets are topped. In gathering the tops from the field care should be taken to have them free from dirt, as it damages the silage. Cut straw should be placed in the bottom of the silo to absorb the excess moisture, and as fast as the tops are cut straw should be mixed with them. In filling the silo special care should be used to have the edges packed firmly. Salt sprinkled over the contents every few inches increases the palatability of the silage. After filling, a 12-inch layer of cut straw should be placed on the top to keep out the air. Other coarse roughage, such as corn or cane stover, can be used in place of the straw. Water should not be added to the silage.

CANE TOPS AND CANE BAGASSE

Tops from sugarcane have been made successfully into silage. The cane tops and leaves should be run through a cutter before they are placed in the silo. Such silage, although not as good as corn silage, can well be used in those sections where sugarcane is grown abundantly, thus utilizing what otherwise would be wasted. Cane bagasse or pomace also makes a fair quality of silage.

SUNFLOWERS

Sunflowers are used to some extent in the West and Northwest, where the weather is too cool and the season too short for the best growth of corn. There seems to be a universal agreement among investigators that sunflowers will yield a much greater tonnage than corn in some localities. As high as 29.75 tons to the acre has been reported by the experiment station at Huntley, Mont. At that station it was likewise found that when planted in rows 20 inches apart the sunflowers gave greater yields than when planted farther apart. The plants were about 10 inches apart in the rows, and 15 pounds of seed were used to the acre. Unless harvested soon after they come into bloom and before the seeds are developed, the silage

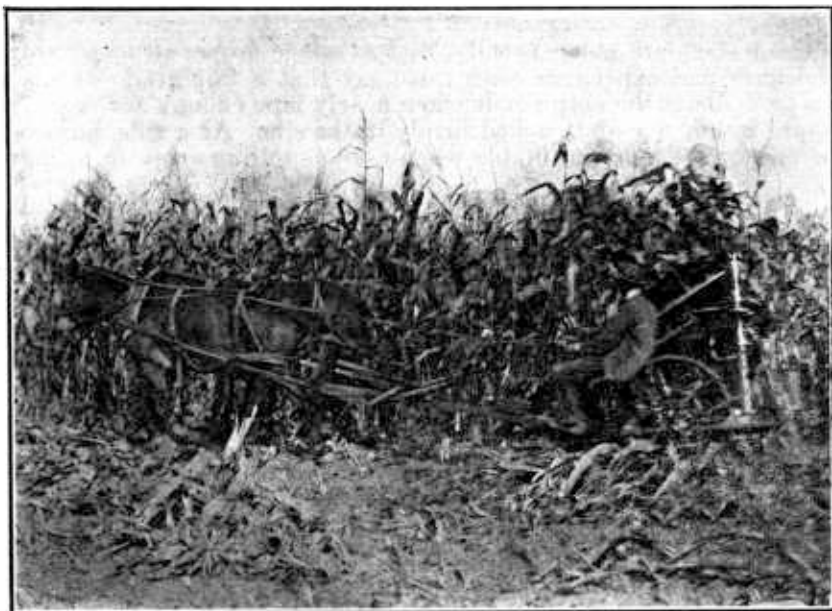


FIG. 3.—A corn harvester at work

will be unpalatable. Sunflowers are not so easily handled as corn, on account of their stiff, brittle stalks, and because the heads tend to clog the feeding rolls of the silage cutter.

Opinions differ as to the feeding value of sunflower silage. In some experiments it seems to be practically equal to corn silage; in others it is inferior. Doubtless the stage of maturity at harvesting time of both the sunflowers and the corn has been partly responsible for this lack of uniformity in results. A composite of all experiments indicates that sunflower silage is neither so palatable nor so valuable, pound for pound, as corn silage, though it may be fully equal to some of the other kinds of silage.

MISCELLANEOUS CROPS

Beet pulp, apple pomace, Russian thistle, and corn husks from canning factories are also occasionally used for silage, but in general are not as satisfactory as other crops.

HARVESTING THE CROP AND FILLING THE SILO

Corn or sorghums for the silo may be cut by hand, with the sled cutter, or with the corn harvester. Hand cutting is practiced on farms where the quantity to be harvested is so small as to make the expense of purchasing a corn harvester too great to justify its use. Under such circumstances, however, two or three farmers may purchase a corn harvester together. Very frequently corn is down or in such position as to make it impossible to cut with either the sled or the corn binder, in which case hand cutting is necessary. Of the three methods, the cost per acre of cutting corn was found to be lowest when the sled cutter was used.⁷ All things considered, however, the corn harvester is more satisfactory.

In using the corn harvester the bundles should be made rather small. While this takes more twine, the extra expense is more than

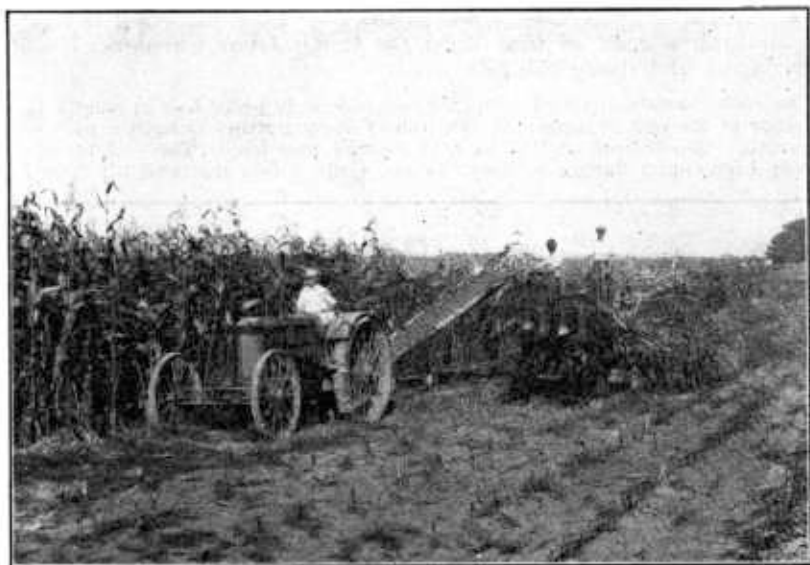


FIG. 4.—Tractor-drawn binder with elevator saves horses and men

offset by the ease of handling the bundles and feeding them into the silage cutter. Two to four horses and one man will be required to run the harvester, which should not get so far ahead of the haulers that the corn will lose any considerable amount of moisture before it is hauled to the cutter.

A bundle elevator which is attached to the corn harvester in place of the bundle carrier has come into use in the last few years. This elevator delivers the bundles to a wagon driven alongside the harvester. Its use eliminates the hardest part of the silo-filling operation. A load of 2 tons can be put on in 12 to 15 minutes. When the elevator is used the power necessary to pull the harvester is increased, and this fact, together with the need for a steady power, makes the use of a tractor desirable. (Fig. 4.)

⁷ See Bulletin 145, Nebraska Agricultural Experiment Station.

HAULING TO THE CUTTER

Ordinarily the corn is hauled to the cutter on a common, flat hay rack. It is best to have this rack mounted on a low-wheeled wagon, even when used in connection with a harvester and elevator. Of course when the loading is done by hand a low-wheeled wagon is much more preferable than a high-wheeled one. (See figs. 5 and 6.)

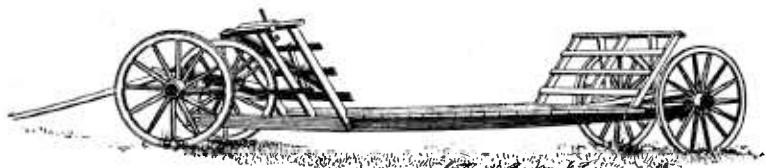


FIG. 5.—A low rack for hauling corn to cutter

A low rack or body can be made easily. The following directions for making a rack of that kind are taken from *Farmers' Bulletin 292*, "Cost of Filling Silos":

The rack consists of two 4 by 6 inch bed pieces, 18 or 20 feet in length, bolted together at the end to form a V. On top of these timbers is built a rack 6 feet in width. The bottom of this rack is about 8 feet long. The end boards are 4 feet high, built flaring so they do not quite touch the wheels. The apex



FIG. 6.—Loading corn on the wagon, the hardest work of all

of the V is suspended below the front axle of an ordinary farm wagon by means of a long kingbolt. The other ends are attached below the hind axle by U-shaped clevises. The materials needed in its construction are 80 board feet of 4 by 6 inch plank, 96 feet of boards 1 by 12 inches, 22 feet of lumber 2 by 4 inches, 1 long kingbolt, 2 stirrup rods, and bolts and nails.

If few teams are available and the haul is long, the load should be as large as possible. With plenty of teams and a short haul the

loads should be smaller, thus saving the labor of high lifting in loading, and facilitating the work of unloading.

CUTTING THE SILAGE

A number of satisfactory silage cutters are on the market. The chief features to be considered in a cutter are that it is strongly made and will cut fine. The capacity is important. The mistake is often made of getting one that is too small, thus making the operation of filling the silo very slow and interfering with the continuous employment of the entire force of men. It is better to get a machine large enough so that every one will be able to keep busy all the time. The larger cutters are equipped with self-feeders, a labor-saving device which the smaller sizes often lack. Other factors to be taken into account are the amount of work to be done and the power to be used.



FIG. 7.—Silage cutter with blower

The usual length of cutting varies from one-fourth of an inch to 1 inch. The latter is a little too long, as the pieces do not pack so closely in the silo and they are not so completely consumed in feeding as the shorter lengths. On the other hand, the longer the pieces the more rapidly the corn can be run through the cutter. Probably most silage is now cut into pieces about half an inch long. Fine cutting and good tramping are needed to make the best quality of silage and fill the silo to greatest capacity.

ELEVATING THE SILAGE

Two types of elevators are in use, the old-style chain carrier and the blower. The chain carrier requires less power but is harder to set up and is not so well adapted for high silos. Some chain carriers are inclosed so as to keep the corn from blowing out. In using

the blower type the blower should be as nearly perpendicular as possible (fig. 7) to reduce to the minimum the friction of the cut corn upon the inside of the pipe and thus lessen the danger of clogging.

POWER REQUIRED

The power necessary to operate the cutter depends upon width of cutter throat, sharpness of knives, type of elevator, height of silo, rate of feeding, and condition of the corn as regards ears and moisture. Less power is required if the cutter is fed below full capacity. It is advisable to have sufficient power to run the cutter at full capacity, and many prefer to have a little surplus power. The figures in Table 3 represent the minimum power needed to run cutters to full capacity. A smaller engine will necessitate slower feeding, especially with heavy, well-eared corn. This table has been prepared from manufacturers' statements, personal observations, and experience, and is not the result of actual experimental tests.

TABLE 3.—Horsepower (gas engine) required to operate silage cutter and blower, with varying widths of cutter throat and varying heights of silos

Width of cutter throat	Height of silo—feet															Approximate capacity
	24	26	28	30	32	34	36	38	40	42	44	46	48	50		
	Horsepower															
10	10.5	10.7	10.8	11.0	11.2	11.3	11.4	11.6	11.8	12.0	12.1	12.2	12.4	12.7	Tons per hour	
12	13.1	13.3	13.6	13.8	14.0	14.1	14.4	14.6	14.8	15.1	15.2	15.4	15.6	15.9	4	
14	15.8	16.1	16.5	16.8	17.1	17.4	17.7	18.1	18.4	18.7	19.1	19.3	19.6	20.2	5	
16	18.5	19.0	19.4	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	7	
18	21.6	22.2	22.8	23.4	23.9	24.6	25.1	25.8	26.4	26.9	27.4	28.1	28.6	29.3	9	
20	25.6	26.1	26.5	27.0	27.6	28.0	28.4	28.9	29.4	29.8	30.3	30.8	31.4	31.8	11	
22	28.6	29.7	30.6	30.8	31.4	31.8	32.4	32.8	33.4	33.9	34.4	34.9	35.3	35.8	13	
24	33.1	33.6	34.2	34.8	35.4	36.6	36.0	37.2	37.5	38.0	38.5	39.2	39.8	40.3	15	
26	36.6	37.3	38.3	39.0	39.7	40.8	41.6	42.3	43.2	44.1	44.9	45.6	46.5	47.3	17	
															19	

If a steam engine is used the horsepower ratings may be 25 per cent less than the above figures. If an electric motor is used the rated horsepower can be 15 per cent less than the figures in the table.

PACKING THE SILAGE

Ordinarily the blower or carrier empties the cut corn or other material into the top of the silo where one or more men distribute and tramp it down. Unless this is done the cut material is thrown too much in one place and the leaves, stalks, and grain are not uniformly distributed. The common practice is to keep the sides slightly higher than the center and to tramp the whole surface thoroughly, especially around the edges. There are some, however, who advocate keeping the center higher, asserting that when the silo is so filled the silage does not draw away from the edges at the top and admit air. Be this as it may, nothing will take the place of thorough tramping.

Various contrivances have been used for distributing the cut material, the one commonly recommended being a metal pipe similar to the blower pipe, but put together loosely in sections. The cut corn from the blower passes down the pipe into the silo, and the pipe being flexible (fig. 8) can be swung so as to place the material anywhere in the silo. With this contrivance it is not necessary to handle

the material with a fork; one man can easily do the work of two, very little loose material flies about in the silo, and the work is much cleaner. Another advantage is a lessening of the chance that the man in the silo will be struck by some object which might be blown up the blower pipe. As the silage rises in the silo the distributor pipe, which is put together in sections, can be readily shortened.

In going into a partially filled silo early in the morning, before the air has had a chance to circulate, there is danger of encountering poisonous gas. To obviate this condition it is a good plan to run the blower a few minutes before entering the silo.

ADDING WATER

In case the material to be siloed has become too dry, water should be added to supply the deficiency of moisture necessary to make it pack properly. Unless well packed, silage will become fire-fanged and will deteriorate through the growth of mold. Enough water should be added to restore the moisture content of the corn to what it would be if cut at the proper stage.

The water may be applied by means of a hose and spray nozzle, directly on the silage in the silo as it is filled; or be run into the blower. In the latter way the water is more evenly mixed with the cut material. When very dry fodder is siloed it is probably better to use both methods in order to wet the fodder sufficiently.

Unless the corn is very green it is a good practice to wet the top of the silage thoroughly as soon as the silo is full. This helps to pack the top layer and lessen the spoilage. The silage should be well tramped every day or two for 10 days after filling and at longer intervals thereafter until used. Unless this is done the silage will draw away from the walls at the top, admitting air and spoiling several feet of silage at the edges.

RONNING METHOD OF MAKING SILAGE

The Ronning method of silo filling has been used to some extent in the last few years. The standing corn is harvested and cut into proper lengths for the silo at one operation, by a combined harvester and cutter. The cut corn is delivered to a wagon box drawn alongside. This is then hauled to the silo and pushed off into a blower which elevates it into the silo.

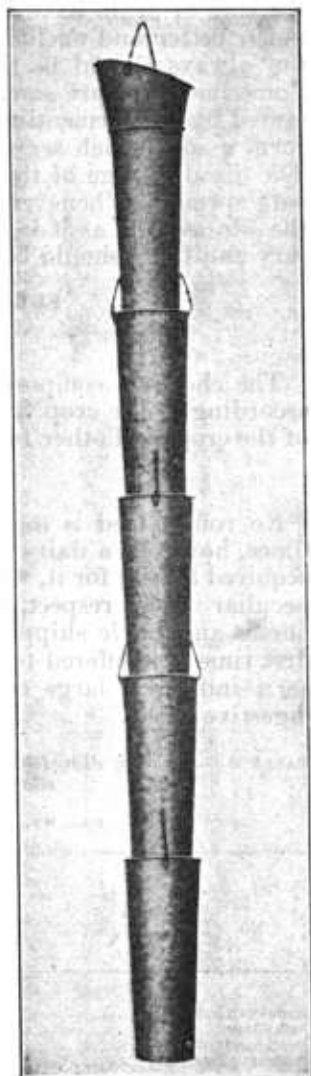


FIG. 8.—Jointed-pipe silage distributor

COVERING THE SILAGE

Formerly it was a common practice to cover the silage with some material, such as dirt or cut straw, in order to prevent the top layer from spoiling. The present means of covering, when any is used, usually consists of a layer of cut corn or sorghum stalks from which the ears or grain have been removed. The heavy green stalks pack much better and exclude the air more effectually than straw. The top always should be thoroughly tramped and then wetted down. Sometimes oats are sown on the top before wetting. The heat generated by the fermenting mass causes the oats to sprout quickly and form a sod, which serves to keep the air out of the silage beneath. The disadvantage of this method is that the silage spoils before the oats sprout. Whenever possible it is better to begin feeding from the silo as soon as it is filled. If this is done, no covering is necessary and there should be no loss on account of spoiling.

FEEDING VALUE OF SILAGE

COMPOSITION

The chemical composition and the nutritive value of silage vary according to the crop from which it is made, the degree of maturity of the crop, and other factors. (See Table 4.)

PALATABILITY

No rough feed is more palatable than good corn silage. Sometimes, however, a dairy cow will not eat silage readily until she has acquired a taste for it, which may require several days. Silage is not peculiar in this respect, however, for it has been observed that range horses and cattle shipped into the Corn Belt often refuse corn the first time it is offered to them. Palatability is of great importance, as it induces a large consumption and stimulates the secretion of digestive juices.

TABLE 4.—Average digestible nutrients and net energy value per 100 pounds of silage and other succulent feeds

(From "Feeds and Feeding," by Henry and Morrison)

Crop	Total dry matter	Digestible dry matter			True protein	Net energy value
		Crude protein	Carbo-hydrates	Fat		
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Therms</i>
Green-corn fodder.....	21.9	1.0	12.8	0.4	0.8	14.60
Corn silage.....	26.3	1.1	15.0	.7	.6	15.90
Green-sorghum fodder.....	24.9	.7	14.8	.7	.4	15.37
Sorghum silage.....	22.8	.6	11.6	.5		
Uncured red clover.....	26.2	2.7	13.0	.6	1.7	15.87
Clover silage.....	24.4	2.0	9.6	.8	.8	7.25
Uncured soybeans.....	23.6	3.2	10.2	.5	2.4	12.53
Soybean silage.....	27.2	2.8	10.8	.9	1.5	11.59
Uncured cowpeas.....	16.3	2.3	8.0	.3	1.7	10.42
Cowpea silage.....	21.2	1.8	9.7	.5	1.1	11.05
Uncured oats and peas.....	22.6	2.4	10.6	.6		
Mangels.....	9.4	.8	6.4	.1	.1	5.68
Sugar beets.....	16.4	1.2	12.6	.1	.4	11.20
Sugar-beet pulp (wet).....	9.3	.5	6.5	.2	.5	8.99
Prickly pear.....	16.5	.4	8.9	.2		
Sunflower silage.....	21.9	1.0	9.8	.8		

SILAGE FOR DAIRY CATTLE

By T. E. WOODWARD and J. B. McNULTY, *Bureau of Dairying*

Silage has been found to be particularly well adapted as a feed for dairy cows, and in consequence silos are more numerous on farms devoted to dairying than on any other kind of farms. In many sections silage has come to be the dairy farmer's main reliance for winter feed.

SUPPLEMENTARY FEEDS

While corn silage is an excellent feed, it is not a complete one for dairy stock. It is too bulky and watery and contains too little protein and mineral matter to meet fully the requirements of the dairy cow. It should be combined with some leguminous hay, such as clover, cowpea, or alfalfa. These will tend to correct the deficiencies of the silage in dry matter, protein, and mineral constituents. However, a ration of corn silage and legume hay without grain is satisfactory only for cows which are dry or which give but a small quantity of milk. Cows in full milk require some concentrated feed in addition to hay and silage, as they can not consume enough of these feeds to keep up a large flow of milk and maintain body weight.

QUANTITY TO FEED

A cow should be fed as much silage as she will clean up without waste when fed with hay and grain. Increase or lessen until the proper quantity is ascertained, bearing in mind that in general a good cow should be fed just short of the limit of her appetite. If she refuses any of her feed it should be reduced at once. The smaller cows eat from 20 to 30 pounds a day, and the larger as much as 40 or more.

RATIONS

In general, dairy cows should be supplied with all the roughage they will clean up, with grain in proportion to the milk or butterfat produced. The hay needed ordinarily ranges between 5 and 12 pounds per cow per day, or 0.8 pound per hundred pounds of live weight when fed in connection with silage. Silage should be fed in the proportion of about 2.5 to 3 pounds per 100 pounds of live weight. For Holsteins 1 pound of concentrates for each 3 or 4 pounds of milk produced, in addition to roughage, is fed. For Jerseys 1 pound for each 2.5 to 3 pounds of milk will come nearer to meeting the requirements. The grain for other breeds varies between these two according to the richness of milk produced. A rule used to some extent is to feed as many pounds of grain daily as there are pounds of butterfat produced weekly. With good silage and plenty of first-class legume hay little grain is needed for cows of ordinary production. Alfalfa especially, if fed liberally, will enable the feeder to reduce the grain allowance to the minimum.

TIME TO FEED

Although good corn silage has no pronounced effect on the flavor and odor of milk, it is probably best to feed it either just after

milking or several hours before milking, to avoid tainting the milk.⁸ Silage is usually fed twice a day.

RATE OF FEEDING

Silage spoils readily when exposed to air or heat. When feeding a uniform layer from the whole surface of the exposed silage should be removed. This layer should be not less than 3 inches thick in summer. It is important that the diameter of a silo for summer use be such that a depth of at least 3 inches of silage can be fed out daily. This is in order that the silage for each day's feed will be as fresh as possible.

If less than a 3-inch layer is taken out daily, some at the top may spoil before the next day.

In cold weather it may be removed slowly as desired, since spoiling does not take place so readily. Silage in a silo from which some had been fed out have been known to keep in perfect condition, except for some drying on the surface, for a month or longer in winter.

As a means of preventing loss from surface spoilage the Missouri Agricultural Experiment Station uses and recommends a canvas covering, treated with hot paraffin to make it air-tight, which is stretched tightly over the silage to within half an inch of the walls upon a circular iron frame. By means of a pulley and rope the canvas can be raised or lowered.

FEEDING FROZEN SILAGE

Frozen silage must be thawed before using, after which it should be fed immediately, before decomposition sets in. No harm will result from feeding such silage, nor is the nutritive value known to be changed in any way.

SILAGE FOR CALVES, BULLS, AND DRY COWS

Calves may be given silage when only a few weeks old. In this case, however, it is of greater importance that the silage be free from mold or decay than when fed to mature stock. At all times calves may have all the good silage they will eat up clean. Yearling calves consume about half as much as mature stock, that is, from 16 to 26 pounds a day if they are well grown. When supplemented with some good leguminous hay, little grain is required to keep the yearlings in a thrifty, growing condition.

An opinion is held by some breeders of dairy stock that a large allowance of silage is detrimental to the breeding qualities of the bull. Whether there is scientific foundation for this opinion remains to be determined. Probably it is a good plan to limit the allowance to about 12 pounds a day for each 1,000 pounds of live weight. When fed in this quantity, silage is thought to be a good, cheap, and safe feed for bulls. It should be supplemented with hay, of course, and with grain also, especially in the case of bulls doing active service or growing rapidly.

Dry cows consume almost as much roughage as when they are at the pail. Silage may well form the principal ingredient of their ration; in fact, with from 25 to 40 pounds of silage and a small sup-

⁸ See Department Bulletin 1097, "Effect of Silage on the Flavor and Odor of Milk."

plementary feed of clover, cowpea, or alfalfa hay—from 5 to 8 pounds a day—the cows will keep in good flesh and even gain in weight. Dry cows in thin flesh should always receive a small quantity of grain. Silage tends to keep the whole system of the cow in good condition and in this way lessens the difficulties of calving.

SILAGE FOR SUMMER FEEDING

One of the most trying seasons of the year for dairy cows is the latter part of summer and early in the fall. At this season the pastures are often short or dried up, and it is a common mistake of dairymen to let their cows decrease in milk flow because of the shortage of feed at that time. Later in the fall it is impossible to restore the milk flow, no matter how well the cows are fed. On good dairy farms the milk flow of the cows is maintained at as high a level as possible, from parturition to drying off. It becomes necessary, therefore, to supply some feed in addition to pasture grass. The easiest way to do this is to feed silage, which is cheaper and decidedly more convenient to use than soiling crops. How much to feed depends on the condition of the pastures, the quantity varying all the way from 10 pounds to a full winter feed.

SILAGE FOR HORSES AND MULES

By GEORGE M. ROMMEL, *formerly Chief of the Animal Husbandry Division,
Bureau of Animal Industry*

(Revised by J. O. Williams, of the Animal Husbandry Division)

Silage is not generally used in horse and mule feeding, but it is a safe feed for either horses or mules if it is of good quality and is carefully fed.

Both horses and mules are peculiarly susceptible to the effects of molds, and under certain conditions varieties of molds are found in silage which are deadly poisons to both of these classes of stock. Such molds are the result of either the improper cutting or packing of the silage, or both. Molds must have air to grow. Silage which is packed air-tight and fed out rapidly will not become moldy. If the feeder watches the silage carefully as the weather becomes warm, he can soon detect the presence of mold. When mold appears, the feeding should be stopped immediately. Similarly, care should be exercised in the winter feeding of silage so that horses or mules are not allowed to eat frozen silage, because of the danger of colic.

Corn silage is the only kind that so far has met with any degree of favor as a horse or mule feed. Corn which is to be ensiled for this purpose should not be cut too green, as sour silage will result, and this may cause colic when fed. Corn for such feed, rather, should be cut when it has begun to glaze, and the silo, once the ensiling process has been started, should be filled as rapidly as possible. When filling the silo it is essential that the corn be carefully and thoroughly tramped and packed. This is one of the most important points in the feeding of silage to horses and mules. Cutting the silage fine and in lengths of less than 1 inch will facilitate packing. If tramping and packing are properly done, no feeding danger is likely to result, but if these operations are slighted, air pockets may

form and cause the accumulation of small masses of mold. Such mold, if overlooked in feeding, may be sufficient to kill one or more of the animals fed.

Silage should not be considered as the principal roughage for horses and mules, but should serve as a partial substitute for hay in the daily ration. Because of its bulky nature, horses and mules doing hard work should not be fed large quantities, but, due to its tonic, laxative, and appetizing effects, it is well suited for the maintenance of idle horses and mules, brood mares, and growing stock. The value of silage is greatest, in the case of horses and mules, as a means to carry them through the winter cheaply or to supplement pasture during periods of drought. When used, silage should be introduced gradually into the ration, and the amount fed should generally not exceed 10 to 15 pounds daily per animal.

SILAGE FOR BEEF CATTLE

By E. W. SHEETS, *Chief of the Animal Husbandry Division, Bureau of Animal Industry*

No roughage occupies a more important place in the economical feeding of beef cattle than silage. The increased value of all roughages as well as of grain has correspondingly increased the value of silage in its various forms for beef production. While silage is not a cheap feed, it is in most cases a great saver of grain as well as of other feeds, whether fed to breeding stock, growing animals, or fattening cattle.

SILAGE FOR THE BREEDING HERD

Silage, when available, should form the principal part of the winter ration for the breeding herd. (Fig. 9.) Cows and calves relish it and thrive upon it when some supplement is added. Silage in the ration creates an appetite for less palatable and cheaper roughages, thus reducing the cost of wintering. As a rule, good legume hays should be fed to the cows suckling calves, unless a protein concentrate such as cottonseed meal or linseed meal is fed with the other roughages. It may also be advisable to feed 2 or 3 pounds of grain in addition, especially if the cows are milking heavily and are somewhat thin in flesh.

The following rations are well adapted to wintering 1,000-pound cows under average conditions and should more than maintain the weight of the cattle

Feeds fed	Average daily amount of feed			
	Ration 1	Ration 2	Ration 3	Ration 4
	<i>Pounds</i> 25 to 30	<i>Pounds</i> 25 to 30	<i>Pounds</i> 25 to 30	<i>Pounds</i> 35 to 40
Silage.....	6 to 8	6 to 8	6 to 8	6 to 8
Legume hay (clover, alfalfa, etc.).....	2 to 4	2 to 4	2 to 4	2 to 4
Nonlegume hay (grass hays, also stover).....	2 to 4	2 to 4	2 to 4	2 to 4
Cereal straw (oat, wheat, rye, etc).....	1½ to 1	1½ to 1	1 to 2	1½ to 2½
Protein concentrate (linseed meal, cottonseed meal, etc.).....				

For dry cows, silage and cheap roughage, such as coarse hays and stover, may be used almost exclusively, thus greatly reducing the

cost of wintering. The amount or even the kinds of roughages and other feed in addition to silage will be determined largely by the quality of the silage. If there is little mature corn in the silage, or if the mature corn was removed before filling the silo, it is necessary to give more silage or to supplement it with other or more nutritious feeds.

Generally good results are obtained in feeding breeding bulls half as much silage as is given to cows. As in the ration for breeding cows a small amount of grain should be supplied in addition to the silage, depending upon the condition of the animal, the exercise or service given, and the nature of other roughages fed.

SILAGE FOR GROWING CALVES

Calves should be fed silage only in limited quantities before they are weaned. Silage is especially relished by calves just weaned. They take to it more quickly than to dry feed and lose but little

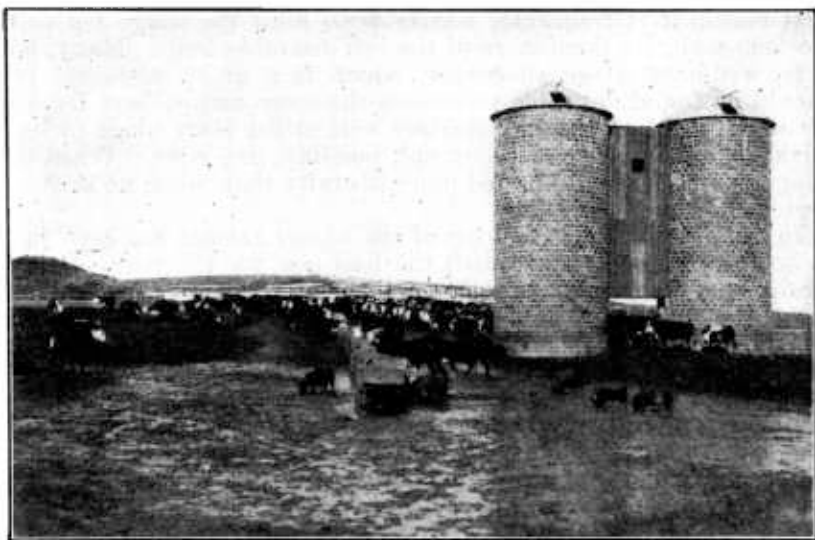


FIG. 9.—Silage is one of the best roughages for wintering the beef breeding herd

weight during the weaning period when they are liberally fed on grain, legume hay, and silage. After they are weaned the amount of silage as well as other feeds should be determined by the use to be made of the calf. If kept for breeding purposes or for finishing at an early age, they should have a more liberal allowance of grain and legume hay. A calf will eat the coarser, cheaper roughages, but as a rule will give greater returns than older cattle from the use of better feeds and dry roughages, such as clover, alfalfa, and lespedeza.

A small quantity of grain should also be given for best results, together with a very little linseed meal, peanut meal, or cottonseed meal.

TABLE 6.—*The following rations will keep a calf weighing from 400 to 600 pounds in a thrifty, growing condition and allow considerable gain during the winter*

Feeds fed	Average daily amount of feed			
	Ration 1	Ration 2	Ration 3	Ration 4
	<i>Pounds</i> 15 to 20 2 to 5	<i>Pounds</i> 15 to 20	<i>Pounds</i> 15 to 20	<i>Pounds</i> 20 to 25
Silage.....				
Legume hay (clover, alfalfa, etc.).....				
Nonlegume hay (grass hays, also stover).....		4 to 6		
Cereal straw (oat, wheat, etc.).....			4 to 6 ½ to 1	
Protein concentrates (linseed meal, cottonseed meal, etc.).....		¼ to ½		¾ to 1½

SILAGE FOR WINTERING STOCKERS

While silage is undoubtedly one of the best feeds for wintering stockers or feeders of all ages, nevertheless one must keep in mind the fact that they make better use of the dry, coarse, cheap roughages produced on the farm than do breeding cows or growing calves. For that reason it is frequently advisable to limit the silage fed to the stockers and give them more of the less desirable feeds. Many, however, withhold silage altogether, which is a great mistake. If it should be found desirable to remove the more mature ears from the corn before filling the silo, stockers will utilize such silage to better advantage than other cattle except, possibly, dry cows. When such silage is used it should be fed more liberally than when no ears have been removed.

In the grazing areas the cost of the winter rations has been found to be approximately two-thirds the feed cost for the year. It is desirable that stockers make some gain during the winter if they are to make the maximum gain for the year. From the standpoint of economy in the ration, silage can hardly be replaced by any other feed for this purpose.

If hay or other dry roughages are scarce and high in price and grain is comparatively cheap, it may be advisable to limit the dry roughage to a few pounds and greatly increase the amount of silage, supplying in addition a protein concentrate, such as cottonseed meal, linseed meal, or velvet beans.

TABLE 7.—*The following rations will usually be found satisfactory for wintering stockers or feeders weighing from 600 to 800 pounds, and should more than maintain the weight of the animals*

Feeds fed	Average daily amount of feed			
	Ration 1	Ration 2	Ration 3	Ration 4
	<i>Pounds</i> 20 to 25 3 to 4	<i>Pounds</i> 20 to 25	<i>Pounds</i> 20 to 25	<i>Pounds</i> 25 to 35
Silage.....				
Legume hay (clover, alfalfa, etc.).....				
Nonlegume hay (grass hays, also stover).....		3 to 4		
Cereal straw (oat, wheat, etc.).....	2 to 4	2 to 4 ½ to 1	6 to 8 ½ to 1	
Protein concentrate (cottonseed meal, linseed meal, etc.).....				1 to 2

The rations suggested for yearlings are especially adapted for feeding older cattle. The amount of silage should be increased 5 to 10 pounds for 2-year-old cattle and 10 to 15 pounds for older cattle, depending upon their size and condition as well as the quality of

silage fed. The dry roughages should also be increased accordingly from 3 to 5 pounds for each year of increase in age or proportionate size.

SILAGE FOR FATTENING CATTLE

The use of silage in rations for fattening cattle varies considerably throughout the steer-killing sections and is governed primarily by other kinds of roughage grown within the areas. In those localities where alfalfa and clover hay are produced abundantly, the use of silage for fattening beef cattle is rather limited, whereas in other areas producing grass hays or mixed hay largely silage is more extensively used. Ordinarily an abundance of cheap, dry roughage lessens the use of silage. The market value of grain also is a determining factor affecting the use of silage. When corn and other grains are high priced, their use in the ration is usually limited and the quantity of silage and protein concentrates is increased.

Experiments have shown that a certain amount of dry roughage should be fed in silage rations. Silage rations usually necessitate a longer feeding period.

TABLE 8.—For 1,000-pound fattening animals the following average rations should be found satisfactory

Feeds fed	Average daily amount of feed ¹				
	Ration 1	Ration 2	Ration 3	Ration 4	Ration 5
	<i>Pounds</i> 25 to 30 1 to 2	<i>Pounds</i> 25 to 30 6 to 8	<i>Pounds</i> 30 to 35 4 to 6	<i>Pounds</i> 30 to 35 6 to 8	<i>Pounds</i> 45 to 50 1½ to 2
Silage.....					
Legume hay (clover, alfalfa, etc.).....					
Nonlegume hay (grass hay, also stover).....					
Protein concentrate, ² (cottonseed meal, linseed meal, etc.).....	2 to 3		3 to 4	4 to 6	2½ to 3
Corn (shelled or broken ear).....	12 to 14	14 to 15	8 to 10		

¹ The amount of the different feeds given is the average to be fed during the entire feeding period. It will be necessary to use smaller amounts at the beginning and increase the feeds gradually until the cattle are on full feed. As feeding progresses the silage and other roughages are gradually reduced and the concentrates increased.

² Where velvet beans (in pods) are used, 2½ pounds will be found approximately equivalent to 1 pound of cottonseed meal.

It should be understood that the rations given are not necessarily to be fed in the exact amounts stated but should be modified to suit local conditions and the feeds available on each farm as well as the prices of the different feeds. It may be found desirable in many sections of the South to substitute cottonseed hulls for nonlegume hays or even for legume hay when the price for the hulls would make such a purchase advisable.

SILAGE FOR SHEEP

By F. R. MARSHALL, *Collaborator in Sheep Investigations, Animal Husbandry Division, Bureau of Animal Industry*

(Revised by D. A. Spencer, of the Animal Husbandry Division)

The use of silage in the winter ration of the flock is increasing. Heretofore many sheepmen have been prejudiced against the use of silage, claiming that it caused abortion and losses of breeding stock. It has been proved by different experiment stations in tests with both

breeding and feeder lambs that good silage is an economical as well as valuable part of the ration. Where moldy, decomposed, or too acid silage is fed losses occur, but judicious feeding of good-quality silage improves the health and vitality of the flock.

SILAGE FOR THE BREEDING FLOCK

No cheaper or better roughage can be fed the breeding flock than good corn silage, which furnishes the succulence so necessary for the maintenance of the health and vitality of the ewes.

A good quality of silage is very palatable, and quantities ranging from 1 to 5 pounds per head per day have been fed in different feeding trials with good results. The quantity to be fed depends on the class of sheep and the character of the other feeds comprising the ration. As a rule, however, not more than 4 pounds of silage per head per day should be fed, and some hay always should be in the ration.

Silage shows the best results when fed with a good legume hay. The following has been found to be a good ration for the breeding ewe:

	Pounds
Corn silage.....	3 to 4
Clover or alfalfa hay.....	2 to 3

Toward the end of the period of pregnancy it would be well to add about one-half to 1 pound of grain to the ewe's ration, thus insuring a strong lamb. If the silage contains a fairly large quantity of grain, however, this increase may not be necessary. If the ewes are in extra good condition at the beginning of winter and do not lamb until the pasture season opens, grain may be dispensed with. Usually earlier lambing and the use of some grain are found to be more profitable, in the latitude of the Corn Belt and the South.

SILAGE FOR LAMBS

In fattening lambs, corn silage not only saves hay and grain but reduces the cost of gains.

Care must be exercised in starting lambs on silage. If too much is given at the beginning of the feeding period, the lambs will probably go off feed and scour. To prevent this, offer a small quantity at the start and gradually increase the daily allowance until they are on full feed. Lambs weighing from 50 to 60 pounds should consume about 1.5 pounds of silage per head per day when receiving grain, and hay in addition. Larger quantities of silage can be fed, but some protein supplement, such as linseed or cottonseed cake, should be added to balance the ration.

A fattening ration for lambs that gave excellent results at the Indiana experiment station is as follows:

	Pounds
Grain (shelled corn, 4 parts, cottonseed meal, 1 part).....	1.1
Corn silage.....	1.38
Clover hay.....	1.12

In wintering ewe lambs, silage should form an important part of the ration, and when fed in conjunction with a good legume hay it not only keeps the lambs in good condition but furnishes a good growing ration.